

1 (d) controlling the performance of the steps (a), (b), and (c) to enhance, in the
2 output produced, the selectivity of said nerve, while the nerve is living in the *in vivo* region of the
3 subject; and

4 (e) processing the output to generate a data set describing the shape and position
5 of said nerve, said data set distinguishing said nerve from non-neural tissue in the *in vivo* region to
6 provide a conspicuity of the nerve that is at least 1.1 times that of the non-neural tissue, without the
7 use of neural contrast agents.

8 ~~93~~ (Amended) The method of Claim ~~92~~⁷, wherein the step of subtracting further includes
9 the step of determining [the] a registration between the first output and the second output.

10 ~~10~~ (Amended) The method of Claim ~~92~~¹⁰⁵, wherein the non-neural tissue includes fat, and
11 wherein the method includes the step of exposing the *in vivo* region to electromagnetic fields that
12 suppress the contribution of the fat in said first and second outputs prior to the steps exposing the
13 *in vivo* region to said first and second gradients[, the *in vivo* region is exposed to electromagnetic
14 fields that suppress the contribution of the fat in said first and second outputs].

15 ~~111~~ (Amended) The method of Claim 110, wherein [said steps (a), (b), and (c) to produce
16 a first output in which] the contribution of nerve is enhanced in said output and [as] said steps (a),
17 (b), and (c) are performed a second time to produce a second output in which the contribution of
18 blood vessels is enhanced, [and] wherein said step (e) of processing the output includes the step of
19 processing [the first and] said output and said second output[s] to suppress the blood vessels from
20 said data set.

21 ~~120~~ (Amended) A method of utilizing magnetic resonance to determine the shape and
22 position of a structure, said method including the steps of:

23 (a) exposing a region to a magnetic polarizing field including a predetermined
24 arrangement of diffusion-weighted gradients, the region including a selected structure that exhibits
25 diffusion anisotropy and other structures that do not exhibit diffusion anisotropy;

1 (b) exposing the region to an electromagnetic excitation field;
2 (c) for each of said diffusion-weighted gradients, [producing an output indicative
3 of the region's] sensing a resonant response of the region to the excitation field and the polarizing
4 field including the diffusion-weighted gradient and producing an output indicative of the resonant
5 response; and

6 (d) vector processing said outputs to generate data representative of anisotropic
7 diffusion exhibited by said selected structure in the region, regardless of the alignment of said
8 diffusion-weighted gradients with respect to the orientation of said selected structure; and

9 (e) processing said data representative of anisotropic diffusion to generate a data
10 set describing the shape and position of said selected structure in the region, said data set
11 distinguishing said selected structure from other structures in the region that do not exhibit diffusion
12 anisotropy.

13 ~~5/60~~ 135. (Amended) A method of utilizing magnetic resonance to determine data
14 representative of diffusion anisotropy exhibited by a structure, said method including the steps of:

15 (a) exposing a region to a suppression sequence of electromagnetic fields that
16 suppresses the electromagnetic responsiveness of structures in the region that do not exhibit diffusion
17 anisotropy, so as to increase the apparent diffusion anisotropy of structures in the region that exhibit
18 diffusion anisotropy, said suppression sequence of electromagnetic fields not including diffusion-
19 weighted magnetic gradients;

20 (b) exposing the region to a predetermined arrangement of diffusion-weighted
21 magnetic gradients, said predetermined arrangement of diffusion-weighted magnetic gradients chosen
22 to:

23 i) emphasize a selected structure in the region exhibiting diffusion
24 anisotropy in a particular direction; and

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1 ii) suppress other structures in the region exhibiting diffusion anisotropy in
2 directions different from said particular direction;

3 (c) for each of said diffusion-weighted gradients, [producing an output indicative
4 of the region's] sensing a resonant response of the region to the diffusion-weighted gradient and
5 producing an output indicative of the resonant response; and

6 (d) processing said outputs to generate data representative of the diffusion
7 anisotropy of the selected structure.

8 139. (Amended) A magnetic resonance apparatus for determining the shape and position of
9 mammal tissue, said apparatus including:

10 (a) [a] polarizing field source means for exposing an *in vivo* region of a subject to
11 a magnetic polarizing field, the *in vivo* region including non-neural tissue and a nerve, the nerve being
12 a member of the group consisting of peripheral nerves, cranial nerves numbers three through twelve,
13 and autonomic nerves;

14 (b) [an] excitation and output arrangement means positioned near said polarizing
15 field source means for exposing the subject to an electromagnetic excitation field;

16 (c) [a] sequence controller means coupled to said polarizing field source means
17 and said excitation and output arrangement means for controlling the operation of said polarizing field
18 source means and said excitation and output arrangement means so that the polarizing field and the
19 excitation field cooperatively induce a resonant response in the *in vivo* region to enhance the
20 selectivity of said nerve while the nerve is *in vivo* and living, said excitation and output arrangement
21 means further for sensing the resonant response of the *in vivo* region and producing an output
22 indicative of the resonant response of the *in vivo* region at a time determined by said sequence
23 controller means; and

24 (d) [a] processor means for processing said output to produce a data set describing
25 the shape and position of said nerve, said data set distinguishing the nerve from non-neural tissue in

1 the *in vivo* region to provide a conspicuity of the nerve that is at least 1.1 times that of the non-neural
2 tissue, without requiring the use of neural contrast agents.

3 140. (Amended) The apparatus of Claim 139, wherein said excitation and output
4 arrangement means includes a phased-array coil system.

5 150. (Amended) A magnetic resonance apparatus for determining the shape and position of
6 a structure, said apparatus including:

7 (a) [a] polarizing field source means for exposing a region to a magnetic polarizing
8 field including a predetermined arrangement of diffusion-weighted gradients, the region including a
9 selected structure that exhibits diffusion anisotropy and other structures that do not exhibit diffusion
10 anisotropy;

11 (b) [an] excitation and output arrangement means positioned near said polarizing
12 field source means for:

13 i) exposing the region to an electromagnetic excitation field; and
14 ii) [producing,] for each of said diffusion-weighted gradients, [an output
15 indicative of the region's] sensing a resonant response of the region to the excitation field and the
16 polarizing field including the diffusion-weighted gradient and producing an output indicative of the
17 resonant response; and

18 (c) [a] processor means coupled to said excitation and output arrangement means
19 for:

20 i) vector processing said outputs to generate data representative of
21 anisotropic diffusion exhibited by the selected structure in the region, regardless of the alignment of
22 said diffusion-weighted gradients with respect to the orientation of said selected structure; and

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ii) processing said data representative of anisotropic diffusion to generate a data set describing the shape and position of said selected structure in the region, said data set distinguishing said selected structure from other structures in the region that do not exhibit diffusion anisotropy.

57 152. (Amended) The apparatus of Claim 151, wherein :

said processor means is further for analyzing said data representative of anisotropic diffusion to determine an effective direction of the anisotropic diffusion exhibited by said neural tissue, so as to determine an optimal orientation for diffusion-weighted gradients;

said polarizing field source means is further for exposing the region to two additional diffusion-weighted gradients respectively substantially parallel to and substantially perpendicular to said effective direction;

said excitation and output arrangement means is further for producing two additional outputs indicative of the region's resonant responses respectively to said two additional diffusion-weighted gradients; and

said processor means is further for determining the difference between said two additional outputs to generate said data set describing the shape and position of said neural tissue.

58 153. (Amended) The apparatus of Claim 151, wherein said data set describing the shape and position of said neural tissue describes the shape and position of a selected cross section of said neural tissue, and said apparatus is further for generating additional data sets describing different cross sections of said neural tissue, and said processor means is further for calculating a further data set that describes the three dimensional shape and position of a segment of said neural tissue by:

analyzing the data representative of anisotropic diffusion to determine how to relate said data set and said additional data sets describing the shape and position of cross sections of said neural tissue; and

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1 based upon the results of said analyzing the data representative of anisotropic diffusion,
2 combining said data set and said additional data sets to generate said further data set that describes
3 the three dimensional shape and position of the segment of said neural tissue, thereby allowing a three
4 dimensional shape and position of curved neural tissue to be described.

5 ~~60~~ ~~155~~ (Amended) The apparatus of Claim ~~150~~ ⁵⁵, wherein:

6 said processor means is further for analyzing said data representative of anisotropic diffusion
7 to determine an effective direction of the anisotropic diffusion exhibited by said selected structure, so
8 as to determine an optimal orientation for diffusion-weighted gradients;

9 said polarizing field source means is further for exposing the region to two additional
10 diffusion-weighted gradients respectively substantially parallel to and substantially perpendicular to
11 said effective direction;

12 said excitation and output arrangement means is further for producing two additional outputs
13 indicative of the region's resonant responses respectively to said two additional diffusion-weighted
14 gradients; and

15 said processor means is further for determining a difference between said two additional
16 outputs to generate said data set describing the shape and position of said selected structure.

17 ~~61~~ ~~156~~ (Amended) The apparatus of Claim ~~150~~ ⁵⁵, wherein said data set describing the shape
18 and position of said selected structure describes the shape and position of a selected cross section of
19 said selected structure, and said apparatus is further for generating additional data sets describing
20 different cross sections of said selected structure, and said processor means is further for determining
21 a further data set that describes the three dimensional shape and position of a segment of said selected
22 structure by:

23 analyzing the data representative of anisotropic diffusion to determine how to relate said data
24 set and said additional data sets describing the shape and position of cross sections of said selected
25 structure; and

1 based upon the results of said analyzing the data representative of anisotropic diffusion,
2 combining said data set and said additional data sets to generate said further data set that describes
3 the three dimensional shape and position of the segment of said selected structure, thereby enabling a
4 three dimensional shape and position of curved structure exhibiting anisotropic diffusion to be
5 described.

6 ~~54~~ 158. (Amended) A magnetic resonance apparatus for determining data representative of
7 the diffusion anisotropy exhibited by a structure, said apparatus including:

8 (a) [an] excitation and output arrangement means for exposing a region to a
9 suppression sequence of electromagnetic fields that suppresses the electromagnetic responsiveness of
10 structures in the region that do not exhibit diffusion anisotropy, so as to increase the apparent
11 diffusion anisotropy of structures in the region that exhibit diffusion anisotropy, said suppression
12 sequence of electromagnetic fields not including diffusion-weighted magnetic gradients;

13 (b) [a] polarizing field source means positioned near said excitation and output
14 arrangement means for exposing the region to a predetermined arrangement of diffusion-weighted
15 magnetic gradients chosen to:

16 i) emphasize a selected structure in the region exhibiting diffusion
17 anisotropy in a particular direction; and

18 ii) suppress other structures in the region exhibiting diffusion anisotropy in
19 directions different from said particular direction, said excitation and output arrangement means
20 further for [producing, for each of said diffusion-weighted gradients, an output indicative of the
21 region's] sensing a resonant response of the region to the diffusion-weighted gradient and producing
22 an output indicative of the resonant response, for each of said diffusion-weighted gradients; and

23 (c) [a] processor means coupled to said excitation and output arrangement means
24 for processing said outputs to generate data representative of the diffusion anisotropy of the selected
25 structure.